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Short Note

Repeated Non-Agonistic Interactions Between a Bottlenose Dolphin (*Tursiops truncatus*) and Sperm Whales (*Physeter macrocephalus*) in Azorean Waters

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While mixed species groups are a commonly observed phenomenon in nature, the functional or mechanistic underpinnings of these interactions are unclear in many cases, particularly among cetaceans (Stensland et al., 2003; Goodale et al., 2010). This lack of understanding arises partly from the scarcity of observations of such behaviours in nature and partly due to difficulties in observing many types of aquatic interactions from a terrestrial perspective. Even when observers are present, many types of interactions occur below water and therefore out of sight of most viewers.

By definition, mixed species groups or associations are characterized as occurring when two or more species are in such proximity that they can be considered members of the same group (Stensland et al., 2003; Goodale et al., 2010). Associations often differ in duration, frequency, and activity, as well as with the habitat, season, and species involved (Stensland et al., 2003). While most interactions typically involve groups of individuals from each of the associating species; on rarer occasions, a single animal will also join a group of heterospecifics (Baraff & Asmutis-Silvia, 1998). Generally, mixed species groups are thought to arise from advantages in terms of predator avoidance or foraging, but they have also been suggested to offer reproductive or social benefits (Stensland et al., 2003). Importantly, multispecies interactions should be the result of attraction between the participants themselves and not reflect aggregations of individuals in areas of clumped resources. Attraction can either be mutual between the species involved or directional so long as the presence of heterospecifics is tolerated by the non-attracted species (Stensland et al., 2003).

Understanding the functional basis underlying mixed species interactions is a crucial factor

when assessing the biological meaning of such occurrences. Stensland et al. (2003) suggest that an important first step in this process is to address two null hypotheses that present alternative explanations for the existence of mixed species groups. First, that the observed interactions are occurring based solely on chance encounters and, second, that the behaviour of the individuals involved is “unaffected” or not directly impacted by the interaction (Whitesides, 1989; Stensland et al., 2003). These hypotheses eliminate risk of potential temporal observer bias as well as ensure that the observed interactions are not simply a byproduct of resource utilization or overlapping habitat use.

Herein we report rare underwater observations of repeated non-agonistic interactions between an adult male bottlenose dolphin (*Tursiops truncatus*) with a vertebral column malformation and a group or groups of sperm whales (*Physeter macrocephalus*) in the Azores in September 2011. While dolphin species are known to frequently engage in mixed species associations, to our knowledge, this is the first time non-agonistic or nonpredatory interspecific associations involving *P. macrocephalus* have been described. We outline the nature and form of these interspecific interactions as recorded from an underwater perspective and while the groups were both swimming and “socializing” at or near the surface.

All observations took place approximately 15 to 20 km offshore (38.331 N to 28.37 W) from Lajes do Pico on the southern coast of the island of Pico. In all instances of underwater observation, a standardized snorkelling protocol was followed in accordance with the rules and regulations governing boat and observer proximity and procedure as outlined in the scientific permit granted by the Azorean government. Surface observations of cetaceans were made from a 5-m

rigid inflatable boat (RIB) and from a minimum distance of approximately 40 to 50 m. When conducting underwater observations, a maximum of two observers entered the water at any given time. All mixed species interactions involving *T. truncatus* and *P. macrocephalus* were observed to be occurring prior to observer arrival and the onset of data collection. Similarly, interactions continued beyond each observation session and, as such, it is not possible to state the total duration of any interactions, though all interactions lasted a minimum of 20 min based on our surface observations of the single identified dolphin (see below) and at least some sperm whale group members. To avoid causing undue stress to the animals, observation sessions took place only once per encounter. We did not follow or chase the group in any manner. As such, an observation period began and ended with the arrival and departure of the group from within an observer's field of view.

On 3 d over an 8-d study period (representing six total observations), a single bottlenose dolphin was observed with one or more variably sized groups of sperm whales. Four of these interactions were filmed below water for varying durations, and for two observations it was not possible to film or enter the water though the identity of the focal dolphin was confirmed in the presence of a sperm whale group (Table 1). No other dolphins were visually observed near the areas of observation when interactions were occurring either spatially or temporally (over the course of several hours), nor was the focal dolphin observed in association with its own or other dolphin species (common dolphin [*Delphinus delphis*], striped dolphin [*Stenella coeruleoalba*], spotted dolphin [*S. frontalis*], and Risso's dolphins [*Grampus griseus*]) when they were observed in the general area at other times ($n = 8$ observations). However, these observations are based solely on visual observations; no acoustic measurements were made. Identification of the focal dolphin was

Table 1. Listed observation durations representing the length of time for which high-quality underwater video footage was obtained, not length of total observation or interaction between cetacea; each observation represents a different data collection period. Behaviours follow the definitions provided in Weilgart & Whitehead (1990), with an additional term of *socializing*, which refers to increased physical contact between group members while milling.

Date & time	Behaviour of group	No. of adults present	No. of subadults present	No. of calves present	Total no. of sperm whales present	Duration of observation underwater	Observers
8 September 2011 (1320 h)	Directed swimming/milling	2	1	2	5	00:03:24	A. Wilson (underwater) J. Krause (surface)
8 September 2011 (1400 h)	Directed swimming	2	0	1	3	00:01:07	A. Wilson (underwater) J. Krause (surface)
8 September 2011 (1630 h)	Socializing/milling	1	1	2	4	00:12:12	A. Wilson (underwater) J. Krause (surface)
13 September 2011 (1200 h)*	Directed swimming	2	1	2	5	Unknown	A. Wilson (surface) J. Krause (surface)
13 September 2011 (1420 h)	Directed swimming	2	1	2	5	00:00:43	D. Thomas (surface)
15 September 2011**(AM)	Directed swimming	Unknown	Unknown	Unknown	Unknown	Unknown	Local guide/naturalist

* Underwater and long-term surface observations were not possible due to presence of an ecotourism vessel in the area; local restrictions do not allow more than one vessel in an area with cetaceans at a time.

** Naturalist present during earlier observations and identification of individual *T. tursiops* with authors. Observations confirmed the presence of the focal dolphin with sperm whales, but sperm whale group composition or duration of interactions was not collected.

possible due to a highly pronounced curvature of the spine (i.e., scoliosis; Berghan & Visser, 2000) that was recognizable from both above and below water (Figure 1a & 1b). The malformation appeared to be a natural birth defect as there was no evidence of scarring or outward injury. The dolphin was a large adult (3 m), and it appeared to be in good condition and able to swim in a relatively natural

manner, suggesting its malformation did not represent an impediment to immediate survival.

Sperm whale calves or subadults ($n = 1$ to 3) and adult females ($n = 1$ to 2) were present in all observations. Observed group size (excluding the *T. truncatus*) varied from three to five individuals (Table 1). Tracking of individual sperm whale calves between observations was not possible due



Figure 1. A mixed species group consisting of sperm whales (*P. macrocephalus*) and a single bottlenose dolphin (*T. truncatus*) in the Azorean archipelago; enlarged photographs illustrate dorsal and ventral views of noted vertebral column malformation in *T. truncatus*, allowing individual identification while the group was socializing or milling (a) or swimming in a particular direction (b) at or below the surface.

to the absence of obvious body markings as filming angles and viewpoints tended to vary between observations, and other identification markers (i.e., tail flukes) were not always visible for all individuals in each instance. However, fluctuations in the presence of unit members between observations would be expected as young calves frequently move between different clusters of adult females and subadults in their social group for protection while adults take turns foraging (see Arnborg & Whitehead, 1989; Whitehead, 1996). This asynchrony in diving behaviour when calves are present is thought to reflect a form of “babysitting” or alloparental care in sperm whales (Whitehead, 1996). In spite of this turnover, in at least two instances it was possible to confirm the identity of an adult female between observation sessions on different days (8 September and 13 September 2011; Table 1) due to obvious individual marks in body scarring along the lateral flanks. Further, in three of the four underwater observations and on two different days the number and relative size of the subadult and calves present were consistent across observations (see Table 1), which in combination with the presence of the same identifiable adult female, might reflect a preferential association with a particular subunit of sperm whales in the area.

All observations occurred while the mixed species groups were either socializing (i.e., milling; Figure 1a) or swimming in a directed manner (Figure 1b) in close proximity at or near the surface (Weilgart & Whitehead, 1990). Typically, the dolphin (as with sperm whale calves) was in constant close proximity to other group members (typically 1 to 2 m), and various forms of physical contact were common between all group members. While contact was initiated by both species, it was three times more likely to be initiated by *T. truncatus*. For example, the dolphin frequently made physical contact with other group members using its flukes (Figure 2a) and pectoral flippers ($n = 12$); nuzzling with its rostrum ($n = 5$; Figure 2b); and rubbing its ventral, lateral, and dorsal areas ($n = 7$) on various parts of the sperm whales (adults, subadults, and calves). Other repeated forms of contact involved the dolphin (1) touching its pelvic region to the lower jaw of various individuals ($n = 2$; Figure 2c); (2) inverting itself such that its dorsal fin made contact with that of others ($n = 2$; Figure 2d); and (3) placing its body perpendicularly directly in front of or between the open jaws of other group members ($n = 5$), typically the largest adult females (Figure 3a).

Sperm whales appeared to treat the dolphin as a conspecific, at times both permitting and initiating physical contact (Figure 3a), and in a manner similar to that seen between other group members



Figure 2. Four forms of physical contact initiated by a bottlenose dolphin while interacting with a group of sperm whales; enlarged photographs show the dolphin (a) touching its fluke to the head of a calf, (b) nuzzling a calf with its rostrum, (c) touching its pelvic region to the lower jaw of a subadult, and (d) initiating dorsal fin to dorsal fin contact.

(both in the form and frequency of interactions between calves and subadults as well as adults present, respectively; Figure 3b & c). Most contact initiated by the sperm whales occurred while socializing at the surface such that individuals would rotate laterally on their body axis and make contact with others using their lateral flanks. In addition, though sperm whale coda vocalisations



Figure 3. Enlarged photographs of a form of physical contact in which (a) a bottlenose dolphin as well as sperm whale (b) calves or (c) subadults would position themselves between or just in front of the open jaws of an adult female sperm whale; this behaviour was also noted to occur between the dolphin and a subadult female sperm whale (inset photo [a]).

were nearly ubiquitous during all observations, vocalisations from the dolphin were only noted occasionally when socializing. However, this would be expected as much of the dolphin vocal repertoire (i.e., broadband clicks) lies outside of the range of the recording equipment used during our observations and, as such, other forms of communication may have been ongoing in some or all of the observation periods that we could not detect.

The manner by which species interact with each other might provide a useful clue to the nature of their association (Struhsaker, 1981). Interspecific interactions can include aggressive (e.g., threats, chases) and non-aggressive behaviours (e.g., play, copulation). Non-aggressive behaviours could possibly strengthen bonds between individuals of different species and make it easier for a mixed species group to form (Stensland et al., 2003). Since

it is clear that the described repeated interspecific interactions were nonrandom and deliberate (on the part of one or both species) and clearly impacted the behaviour of individuals involved (as suggested by the actions and responses displayed by both species), the alternative null hypotheses (i.e., the observed interactions are based on [1] chance encounters or [2] that the behaviour of the individuals is unaffected by the encounter) for interspecific associations proposed by Stensland et al. (2003) can be rejected. Mixed species interactions between dolphin species (including *T. truncatus*) are common in the waters of the Azorean archipelago, and explanations have varied from foraging benefits to adaptive responses to changing environmental conditions (Querouil et al., 2008). In many instances of mixed species groups, functional explanations have involved either predator avoidance or foraging benefits (*sensu* Stensland et al., 2003). A predator avoidance hypothesis would suggest that one or both species gain some benefit in each other's presence through increasing either their ability to detect or to deter potential predators. The rare malformation observed in our focal individual may put it at a particular disadvantage when confronted with a potential predator and may make such mixed species associations for protection more probable. For example, close proximity to the sperm whales might in itself offer some antipredator benefits to the dolphin as while it seems the dolphin's malformation did not impede its ability to swim and forage (based on its noted good condition and swimming abilities, and which has also been noted in other delphinids with similar vertebral column malformations; Berghan & Visser, 2000), it may have been sufficient to restrict the dolphin's ability to successfully associate with other faster and more mobile members of its own species for security purposes. However, it should be noted that an entirely antipredator-based hypothesis might be unlikely given the scarcity of potential predators (i.e., large shark species, killer whales [*Orcinus orca*]) capable of preying on adult bottlenose dolphins in Azorean waters (Querouil et al., 2008). Furthermore, this mechanistic explanation fails to explain the observed directed interactions between species, which suggests that an additional related or independent mechanism is responsible for these mixed species interactions.

A foraging advantage hypothesis would imply that one or both species benefit in terms of foraging success or ability due to the presence of the other species. However, while the habitats of both species do overlap, the extreme divergence in foraging style and location between *P. macrocephalus* and *T. truncatus* makes this possibility unlikely as a sole mechanistic explanation. For example, female sperm whales are deep-water specialists

and known to forage primarily on mesopelagic and bathypelagic squid (Kawakami, 1980), whereas bottlenose dolphins are more opportunistic, feeding on a variety of different prey types (primarily fishes) in shallower water (Shane et al., 1986). Given the tendency of *T. truncatus* to exploit novel or opportunistic food sources (Leatherwood, 1975), an interesting exception to a foraging hypothesis would be if the dolphin were exhibiting some form of kleptoparasitism, wherein it was able to feed on remnants of squid or other prey which were brought to the surface or regurgitated by adults or subadults when surfacing from a foraging dive (see Clarke & Paliza, 2001; Gallo-Reynoso et al., 2009). That said, we did not observe any individuals to be engaging in feeding behaviour at anytime during the observation periods.

A third hypothesis would be that one or both of the species involved gain some benefit in terms of social or reproductive advantages. While reproductive advantages are impossible in this case given the species involved, Querouil et al. (2008) proposed that social benefits of mixed species interactions may take the form of the ability to engage socially in the absence of competition (sexual or otherwise). Although *P. macrocephalus* and *T. truncatus* both exhibit marked differences in terms of ecology, reproduction, and social habits, both species are highly social and thought to possess significant cognitive abilities (Caldwell et al., 1966; Shane et al., 1986; Connor et al., 1998; Connor, 2007). Thus, the notion of a social explanation, at least in part, seems most plausible, though the exact mechanism and potential benefits to either species remain unclear. One hypothesis would be that the acceptance of the dolphin into their social group represents a form of transspecific epimeletic (attention or care giving) behaviour (Pilleri, 1984). While sperm whales are not currently known to exhibit such behaviour towards other species, they are known to exhibit considerable altruism to injured members of their own species (Caldwell et al., 1966). Further, epimeletic behaviour is rather common among other species of Cetacea (Pilleri, 1984), including *T. truncatus* (Cockcroft & Sauer, 1990; Harzen & dos Santos, 1992; Warren-Smith & Dunn, 2006), and may therefore be a likely catalyst for mixed species interactions.

The observed interactions might also be due to misplaced alloparental care on the part of *P. macrocephalus* (Whitehead, 1996). Since adult female sperm whales alternate foraging dives so as to accompany and/or provide continual support and protection to their own and other females' calves in the group, it is possible that the presence of the lone adult dolphin among the sperm whale calves was accepted as representing another calf. In possible support for this notion, the dolphin tended to

be observed swimming next to the calves in the group when the group was moving. If the dolphin used the calves as guides while the group moved from area to area, it might explain the temporality of the association. Since calves cannot dive very deep or for long durations, it may have allowed the dolphin to remain with the group since only adults and large subadults can dive to forage. At the very least, the presence of the dolphin was tolerated; however, given the frequency and types of interaction between species, it would appear to represent more than simple tolerance. Some have argued that social behaviours (i.e., epimeletic behavior) may represent more of an instinctual response rather than a cognitive one in cetaceans (Pilleri, 1984). If so, this may suggest that the lone dolphin travelling with the group(s) may be accepted as a group member simply because it was nonthreatening and sociable. On the other hand, the non-aggressive types of interactions we observed could possibly strengthen bonds between species and make it easier for the mixed species group to form and persist over time irrespective of underlying function (Stensland et al., 2003). For the dolphin, this interspecific association may have represented an opportunity to get the potential benefits of being in a group (e.g., social interaction, protection) when interaction with its own species was not possible or was otherwise undesirable.

Lastly, the observed interactions could represent a form of social "play" for one or both species involved. Deakos et al. (2010) recently documented instances of non-agonistic interspecific physical interactions between individual *T. truncatus* and much larger humpback whales (*Megaptera novaeangliae*) in Hawaiian waters and interpreted these interactions to be representative of object and social play. Since in our observations, *T. truncatus* and *P. macrocephalus* were also both observed to be displaying various physical forms of affiliative interactions (i.e., touching with various parts of the body), a social play hypothesis might also be supported.

In conclusion, mixed species groups are a well-known phenomenon in cetaceans, but difficulties associated with studying these interactions in marine habitats has limited the available amount of data and literature on this topic, particularly with regard to its functional basis (Stensland et al., 2003). While many studies have shown that dolphins, including *T. truncatus*, will often join groups of at least 16 other marine mammal species, including other large cetaceans (reviewed in Deakos et al., 2010), for foraging, antipredator, or social benefits among others (Baraff & Asmutis-Silvia, 1998; Stensland et al., 2003; Querouil et al., 2008; Deakos et al., 2010), our study is the

first to observe such non-agonistic interactions between *P. macrocephalus* and any other species. While we can only speculate as to the underlying mechanism of the observed interspecific interactions, evidence would suggest that such interactions convey some form of social benefits to one or both species, perhaps in conjunction with foraging or antipredator benefits to *T. truncatus*, though we were unable to provide direct evidence of these secondary hypotheses. Nonetheless, our observations provide an important first insight into the mechanistic basis of mixed species interactions in *P. macrocephalus* and additional information regarding such behaviour in *T. truncatus*. Additional study is required to document the frequency, temporal duration, and ecological relevance of such interactions among cetaceans as well as to develop a better understanding of the mechanistic underpinnings of the behaviours described herein.

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